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MASSACHUSETTS ASSOCIATION

OF

BOARDS OF HEALTH.

ISSUED QUARTERLY.

PUBLISHED BY
W. S. FRENCH, WEST NEWTON, MASS.

OFFICERS

OF THE

MASSACHUSETTS ASSOCIATION

OF

BOARDS OF HEALTH.

1890.

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TREASURER,

JAMES B. FIELD, M.D., Chairman Board of Health, Lowell, Mass.

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(For Two Years.)

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(For One Year.)

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Press of
C. W. Calkins & Co.,
Boston.

MASSACHUSETTS ASSOCIATION OF BOARDS OF HEALTH.

ORGANIZED 1890.

Vol. I. January, 1891. No. 1.

This Association, as a Body, is not responsible for statements or opinions of any of its members.

PRELIMINARY MEETING.

In response to the following circular

OFFICE OF THE BOARD OF HEALTH,
Worcester, Mass., Nov. 8, 1889.

TO THE BOARD OF HEALTH IN ———.

Gentlemen: — It has been suggested that a Society could be formed to advantage, comprising the various Boards of Health throughout the state of Massachusetts.

This Society should hold meetings annually, or oftener, in different places, at which a dinner could be served. The objects should be:

1st. To discuss topics, and hear papers of sanitary interest.

2d. To aid legislation and secure uniform interpretation and enforcement of existing statutes.

3d. To compare the rules of local boards and city ordinances, for the purpose of advance in sanitary matters.

4th. To secure co-operation between local boards, for the suppression of disease, especially epidemics, and for the abatement of nuisances.

5th. To establish pleasant and helpful social relations among the Boards of Health through the state.

Will you please send your opinion of this matter as early as convenient, and any suggestions that you may like to offer?

Very truly yours,

L. F. WOODWARD, M.D.,
Chairman of Worcester Board of Health.

thirty-five gentlemen connected with twenty-four Boards of Health in the state, met at Huntington Hall, Institute of Technology Building, Boston, on Saturday, Jan. 11, 1890, at two P.M. Dr. S. H. Durgin, of Boston, was chosen Chairman, and Dr. J. B. Field, of Lowell, Secretary, for the purposes of temporary organization. Dr. L. F.

Woodward, of Worcester, then explained the origin of the proposed organization. The Worcester Board of Health had sent to every city and town in the state of over two thousand population, a circular relative to the formation of an association of Boards of Health. The replies to this circular were so favorable that the Boston Board of Health issued a call for the present meeting.

After a general and informal discussion of the needs, work and benefits of such an organization, the following gentlemen were chosen a committee to draft a Constitution and By-Laws and to nominate a list of officers, with instructions to report within sixty days: L. F. Woodward, M.D., H. P. Walcott, M.D., S. H. Durgin, M.D., J. A. Gage, M.D., W. K. Knowles, M.D., J. B. Field, M.D.

Mr. Babbitt, *of Boston:* — I move that the next meeting be held in Boston as soon as the above committee is ready to report, and that the Boston Board of Health shall have charge of the arrangements for the same, at which a subscription dinner, costing not more than $1.50 per plate, shall be given.

The motion was adopted with applause.

Adjourned, subject to call of Boston Board of Health.

FIRST REGULAR MEETING.

The first regular meeting of the organization was held at the Revere House, Boston, March 19, 1890, and was called to order by the temporary Chairman, Dr. Durgin.

The records of the preliminary meeting were read and approved.

The Committee on Constitution made its report, and submitted a draft of a Constitution, which, after a few amendments suggested by the members present, was adopted.

The Committee on Nominations of Officers for the ensuing year submitted its report, which was accepted, and the following nominees were unanimously elected:

President, Henry P. Walcott, M.D. (Chairman of State Board of Health and member of Cambridge Board of Health.)

First Vice-President, Samuel H. Durgin, M.D. (Chairman of Boston Board of Health.)

Second Vice-President, Samuel W. Abbott, M.D. (Secretary of State Board of Health and member of Wakefield Board of Health.)

Secretary, LEMUEL F. WOODWARD, M.D. (Chairman of Worcester Board of Health.)

Treasurer, JAMES B. FIELD, M.D. (Chairman.)

Executive Committee, the preceding officers *ex-officio:* For two years — J. E. CLARK, M.D., Medford; W. H. CHAPIN, M.D., Springfield; W. K. KNOWLES, M.D., Everett; E. A. SAWYER, M.D., Gardner; W. S. FRENCH, West Newton. For one year — C. H. MORROW, M.D., Gloucester; A. G. GRIFFIN, M.D., Malden; M. R. DONOVAN, M.D., Lynn; G. L. TOBEY, M.D., Lancaster; H. HARLOW, Plymouth.

Dr. Walcott on taking the chair, after thanking the Association for the honor conferred upon him by making him its first President, made a few remarks upon the objects and work of the Association, and the necessity for united, energetic and intelligent action by its members.

THE PRESIDENT stated that he would appoint the Committee on Papers and Publications at the next meeting.

Mr. BABBITT — I move that the Secretary be instructed, in behalf of the Association, to extend its sincere thanks to Gen. Francis A. Walker for the use of Huntington Hall at the preliminary meeting of the Association.

The motion was adopted by a unanimous vote.

Voted, That five hundred copies of the Constitution and By-Laws, with a list of members, be printed.

Adjourned.

At the close of the business meeting about sixty members sat down and enjoyed the elegant dinner prepared by the proprietor of the Revere House. A general social chat and good time wound up an enjoyable meeting.

SECOND REGULAR MEETING.

LOWELL, MASS., June 19, 1890.

The second regular meeting of the Association was holden by invitation of the Lowell Board of Health at Lakeview Park, the summer resort of the citizens of Lowell.

Upon their arrival the members of the Association became the guests of the Lowell Board of Health, and were taken on a carriage ride through the city, visiting among other points of interest Fort Hill Park, Belvidere and "Little Canada." Upon returning from this ride, special electric cars were taken to Lakeview Park. Before dinner a steamboat ride was taken around the lake. About fifty members sat down to dinner, which was served in the upper hall of the pavilion overlooking the lake. After discussing a delightful ménu the President, Dr. Walcott, rapped the meeting to order, and after cigars had been lighted, Dr. Field, Chairman of the local Board, introduced His Honor, Charles D. Palmer, Mayor of Lowell.

The Mayor welcomed the Association to Lowell in a felicitous address, in which he referred to the importance of sanitary work, and the value to a community of a well-organized Board of Health.

The records of the last meeting were read and approved.

Dr. Field then read a paper on "The Disposal of Garbage," which was listened to with great interest.

The discussion upon the paper was opened by Dr. Charles V. Chapin, Superintendent of Health of Providence, who was followed by Dr. J. Arthur Gage of Lowell, and others, which was hurriedly brought to a close by the necessity of reaching the trains.

The President — We will now take up the consideration of applicants for membership.

The Secretary — I have the following list of applicants for membership, who have been passed by the Executive Committee, and are recommended to the Association for election: —

F. W. Draper, M.D., Boston, Mass.

Charles V. Chapin, M.D., Supt. of Health, Providence, R.I.

F. W. Jackson, M.D., Weston, Mass.

L. F. Severance, Brockton, Mass.

David E. Baker, M.D., Newtonville, Mass.

The names as submitted were unanimously elected to membership.

The President — I will appoint as the Committee on Scientific Papers and Publications the following members: —

Samuel H. Durgin, M.D., *ex-officio*, Boston.

David E. Baker, M.D., Newtonville.

Ernest S. Jack, M.D., Melrose.

Voted, To refer the matter of the next meeting to the President and Secretary with full powers.

Voted, To extend the thanks of the Association to the Lowell Board of Health and its Chairman, Dr. Field, for the many courtesies received.

Adjourned.

THIRD REGULAR MEETING.

WORCESTER, MASS., Oct. 15, 1890.

The third regular meeting of the Association was held at Worcester by invitation of the local Board.

The members of the Association met at the office of the Board of Health at 1.30 P.M. Barges were then taken, and a visit made to the city's works for purification of the sewage, the party being in charge of the City Engineer, Chas. A. Allen. After a thorough inspection of the works, the Association were driven back through various parts of the city to the Worcester Polytechnic Institute, where the regular business meeting was held, the visitors first being shown over the building.

In the absence of the President, the first Vice-President, S. H. Durgin, M.D., took the chair.

The records of the last meeting were read and approved.

THE VICE-PRESIDENT — The first business before the meeting will be action on the propositions for membership.

THE SECRETARY — I have the following list of applicants for membership, who have been passed by the Executive Committee, and are recommended to the Association for election: —

Prof. T. M. Drown, Massachusetts Institute of Technology, Boston, Mass.

Prof. W. T. Sedgwick, Massachusetts Institute of Technology, Boston, Mass.

Prof. L. P. Kinnicutt, Worcester Polytechnic Institute, Worcester, Mass.

Charles A. Allen, City Engineer, Worcester, Mass.

Edwin D. Wadsworth, Milton, Mass.

C. L. French, M.D., Clinton, Mass.

T. H. O'Connor, M.D., Clinton, Mass.

T. F. Roche, M.D., " "

P. T. O'Brien, M.D., " "

P. P. Comey, M.D., " "

James Kimball, Agent Board of Health, Springfield, Mass.

By vote of the Association all the foregoing parties were unanimously elected to membership.

Prof. Leonard P. Kinnicutt, of the Worcester Polytechnic Institute, then read a paper on "The Disposal of Sewage, together with an account of the Worcester Sewage Works," which was discussed by Profs. T. M. Drown and W. T. Sedgwick, of the Massachusetts Institute of Technology, Boston, and Mr. Charles A. Allen, City Engineer of Worcester, after which the discussion became general.

A vote of thanks was then passed to Professors Kinnicutt, Drown and Sedgwick and City Engineer Allen, for the interesting and valuable papers and information given; also to the Worcester Board of Health for the courtesies received from them.

Adjourned at 5.30 P.M. for dinner at the Bay State House, which was attended by about fifty members, several being obliged to leave at the close of the business session.

THE DISPOSAL OF GARBAGE.

BY JAMES B. FIELD, M.D., CHAIRMAN OF LOWELL BOARD OF HEALTH.

(Read at the meeting held at Lowell, June 19, 1890.)

THE consideration of how to properly dispose of the waste materials of a city has given rise to many problems of sanitary science. Under the head of waste products will come a variety of substances which directly or indirectly engage the interest of the sanitarian.

The human body produces several kinds of organic waste. Thus the disposal of urine and fæces, and of the air rendered impure by respiration, leads to the problems of house drainage and ventilation. The disposal of ashes, house-dirt, and street-sweepings also comes within the province of the health officer. Then, again, there are the waste products of manufactures, some of which vitiate the air by their odors, and others of which pollute the streams of water into which they are discharged. Even the subject of disposal of the dead would come under this head.

The present paper does not treat of the disposal of all varieties of waste material, but only of one kind, not as yet mentioned. I refer to the refuse of food-stuffs as found in the household and in the markets, and known as garbage.

Before entering upon a discussion of the disposal of garbage, we ought briefly to consider the methods of its collection. These may be divided as follows: —

1. Collection by private individuals without license or control.
2. Collection by licensed swill-gatherers.
3. Collection by a contractor.
4. Collection by the municipality.

In the small country village nearly every household disposes of its own swill. Perhaps, however, the doctor, the minister, and the postmaster do not keep pigs, but dispose of their table refuse to their neighbors. This may be the first point in the evolution of the swill-

collector. As the village grows into a town, with manufacturing interests, the need for gatherers of garbage increases. Enterprising farmers, with cattle and pigs to feed, obtain this refuse matter for little or nothing. They gather it wherever they please, whenever they please, and transport it in any kind of a receptacle or conveyance. This is altogether wrong. Swill should be collected at regular and frequent intervals, and in an inoffensive manner. Fortunately, this can be seen to, even in our smallest towns. The power given by the Public Statutes allows Boards of Health to make such regulations as are necessary for the public health, and under this head would certainly come a rule which should place such restrictions upon the collection of garbage as the following:

1. Each collector of swill should be obliged to obtain permission of the Board of Health before pursuing his calling.

2. The receptacles used to convey the refuse should be watertight and securely covered, so that no odors could escape.

3. The collector should be obliged to furnish a list of places from which he takes swill, and should be required to visit these places at least every second day.

There is no doubt that every town in the state can thus compel its swill-gatherers to be licensed, and to comply with restrictions similar to the foregoing, or even more rigid. To enforce such measures, fortunately, requires no expenditure of money, but simply an expenditure of energy by members of the Board of Health, and a few prosecutions in the police court.

The licensed collector, thus hemmed in by restrictions, inspections, and fear of prosecution, will do the work much better than the man who is allowed to run wild.

Much more preferable than licensed collectors is the man who does the work by contract, for it is much easier to hold one man responsible than it is to look out for several collectors, each infringing on the other's territory.

The ordinary contractor will bear watching. He collects the city's refuse, not because he is a philanthropic sanitarian, but because he is on the make. To keep down expenses means to do the work in a slovenly manner. The garbage contractor, therefore, should be compelled to live up to a carefully-drawn set of rules. The only satisfactory way, however, to have a city's refuse collected, is to have it done by the health department. It will not do to intrust this work to

the street department, the pauper department, or to any other branch of municipal work. It must be under the direction of men who believe the cheapest way to do sanitary work is to do it well. In other words, the ideal way of collecting garbage is to have it done by the employees of the Board of Health.

Far more important than the methods of collecting garbage are the methods of its disposal. We may divide these methods as follows: —

1. Use of garbage as a food for animals.
2. Disposal of garbage upon the land or upon bodies of water.
3. Destruction of its garbage by fire or by extraction of its valuable constituents.

Until recent years the custom was well nigh universal of using swill as a food for cattle and swine. Sanitarians have long recognized the harmfulness of such procedures, but it is only recently that the laity have begun to be aroused on the matter.

The fact that a diet of swill will at times increase the percentage of solids in cow's milk is known not only to the health officer and the chemist, but also to the dairyman. A chemical analysis, however, does not reveal all the qualities of a sample of milk. Whether bacteriological examinations would show that the milk came from swill-fed cows is not known. Two years ago Dr. Abbott, of the State Board, informed the writer that but little had been done in this line of work, and that no definite results had been obtained. Clinical evidence as to the injurious effects of swill milk is very strong. Many farmers assert their ability to distinguish such milk by its odor, and state that fermentative changes occur very rapidly. It is also well known that cows fed on a diet of swill are feverish, restless, and not in a natural state of health. What is of more importance is the fact that the effects of swill milk as an infant diet are extremely injurious. Even if we did not have all this evidence against the use of swill as a food for cows, the mere fact that it is an unnatural food would show that it could not have a favorable effect upon cows or upon the secretion of milk.

Now if a town has to dispose of its swill to outside parties, how can it prevent that abomination of abominations — the use of swill as a food for cows?

Last year, by request of the Lowell Board of Health, a bill was introduced into the Legislature permitting the Board of Health of a city to inspect the premises of all persons whose cow's milk came into the

city, and the premises of all persons who obtained swill from the city. A penalty was provided against the owner of the premises on which swill was found being fed to cows.

Several Boards of Health were present at the hearing before the Committee on Public Health, and the testimony introduced went to show that the effects of swill as a food for cows were similar to those just mentioned. All parties at the hearing were of one mind in wishing that some bill similar to the one proposed, should be passed. The committee, feeling that a bill as strict as the one desired would fail of enactment, substituted the following modification, which became a law May 9, 1889:

[CHAP. 326.]

AN ACT TO PREVENT THE FEEDING OF GARBAGE, REFUSE OR OFFAL TO MILCH COWS.

Be it enacted by the Senate and House of Representatives in General Court assembled, and by the authority of the same, as follows:

Whoever knowingly feeds or has in his possession with intent to feed to any milch cow, any garbage, refuse or offal collected by any city or town, or by any person having authority from any city or town, by contract or otherwise, shall be punished by imprisonment in the jail or house of correction not exceeding sixty days or by fine not exceeding one hundred dollars. [*Approved May 9, 1889.*]

With this law on our Statute Books, the use of swill as a food for cows could be stopped within our state if every town had the will and means to inspect all dairies within its borders, and would prosecute all offenders. Concerted action is what is needed.

Perhaps, however, the Board of Health of some city will say, "What is the use of starting a crusade against swill milk? The surrounding towns are indifferent, and why should we forbid our milkmen to feed swill, when swill milk is brought daily into our city from neighboring towns?"

To such queries we can only reply, that it is far better to partially abate an evil than to make no attempt at all to remedy it.

The Board of Health of a city can, however, obtain the right to inspect dairies in neighboring towns, and thus see that the law is complied with. This right of inspecting dairies in other towns is not given by legislative act, but is acquired in a very simple manner; that is, by refusing to allow any swill to be taken out of the city, without

receiving the privilege of inspecting the farms to which it goes. This method may not be practicable in some communities, but it is certain that the Lowell inspectors are dreaded by the farmers of Dracut, Pelham, Tyngsborough, Chelmsford and Tewksbury.

In some cities the opportunity of feeding swill to cows is reduced to a minimum by the city establishing a piggery to utilize all the city swill. In theory, such a piggery is an intolerable nuisance. The decomposing swill and the presence of large amounts of swine manure, must give rise to an unbearable stench. A practical example of this kind of nuisance and a good warning to all cities contemplating the establishment of a piggery, may be found in one of our Massachusetts cities, in which the pauper department carries the swill to the city farm, where it is fed to nearly six hundred pigs. The process of feeding is carried on partly in an open lot, where the loads of swill are dumped upon the ground. After the pigs have eaten what they desire, the remainder of the garbage is allowed to decompose, thus filling the air with offensive odors. It is but simple justice to the city in question to state that its Board of Health has vigorously fought against the piggery with all its might.

The feeding of swill to hogs is more than a nuisance, for it is dangerous to public health by giving rise to the disease known as trichinosis. This disease in hogs is also propagated to human beings who partake of pork flesh that is not thoroughly cooked. Although epidemics of human trichinosis are much more common in Germany than in this country, yet several cases with a high mortality rate have occurred in our Western states. So far as is known, but few cases are on record in Massachusetts. The interest in the subject of trichinosis has been heightened by the investigations of Dr. Mark, which appeared in the last report of our State Board of Health. He concludes that although hogs may obtain trichinosis from eating trichinous rats, that still by far the greater number of trichinous hogs found in the vicinity of Boston in all probability become trichinous by eating city swill which contained pieces of raw swine-flesh in which trichinæ were imbedded.

Even if there were no danger of trichinosis, yet it is well known that hogs fed upon city swill are not healthy, and that deaths are frequent among them.

Thus step by step do we see that swill is not a suitable food for cows, nor even for hogs. How, then, can we dispose of it?

If garbage is used to fertilize the ground, a large acreage will be required, and it can readily be seen that the process is a nuisance, even if the garbage is plowed into the soil.

To place garbage on a dump is wrong, even if a load of garbage is immediately covered by a load of ashes. A house which has its cellar in a foundation of such material is not fit to live in.

Many communities deposit their refuse matter in some body of water. This method is, however, restricted to towns on the seaboard or on the bank of some swiftly-flowing river. It must be an expensive process to dump all the garbage of a city in the ocean, far away from the channel and from all chances that the refuse matter will be again cast upon the shore.

A town which deposits its garbage in any river or other body of water which is a source of public water supply, by so doing violates the laws of this state. Thus this method of disposing of garbage cannot be availed of.

There is no method which will satisfactorily dispose of garbage without destroying its characteristics. This can be done either by burning the garbage, or else by extracting its valuable constituents.

One solution of the problem of garbage destruction, so far as private families are concerned, is that each family should destroy its own swill. Cook-stoves have been constructed with a receptacle at one side of the fire-box, in which the swill can be subjected to the action of the heat without interfering with the efficiency of the fire. In this way the garbage is gradually dried, and may finally be used as fuel. In the summer, when oil-stoves and gas are largely used for cooking, it would, perhaps, be necessary to saturate the garbage with kerosene before building a temporary fire in the kitchen stove to consume it. Such methods, however, presuppose an amount of intelligence and willingness not found in all our kitchens. This plan must therefore be dismissed as impracticable for universal adoption. Even if this method could be adopted only by the better class of householders, a large saving would be made, not only in the amount of garbage to be destroyed, but also in the expense of collection.

In most cities there is not only house offal, but also the refuse from fruit stores and provision markets. The waste from meats is generally utilized either in soap factories or in fertilizer works. Decayed apples, bananas, oranges, and all other such material should be destroyed in the same manner as swill. There are now very many

cities which wholly destroy their garbage. This admirable plan is in force even in some quite small municipalities. In this particular form of sanitary improvement, which is being adopted throughout the country, western and southern cities have led the van. As has already been stated, there are two methods of destroying garbage. One is by burning the waste material; the other is by extracting grease and other useful products from the garbage. This latter method is known as the Merz system.

In this system of garbage extraction the waste material is received in a large iron cylinder, known as the dryer. In this the garbage is thoroughly stirred and mixed by revolving arms of iron tubing. Surrounding this drying cylinder is a jacket cylinder. Between the two cylinders and also into the two hollow arms of the stirrer is forced superheated steam. The garbage remains in the dryer six or eight hours, subjected by this steam to a temperature of from 250° to 300° F. This heat, acting on the liquid portion of the garbage, forces out a vapor containing all the moisture and noxious gases. By suction-fans this vapor is led into a condenser, from which it emerges as a colorless liquid with a slight odor. Nearly, if not quite, two-thirds of the garbage thus passes off as moisture. The remaining third is removed from the dryer and then conveyed to air-tight vats or extractors, in which it is subjected to the action of benzine and other chemicals for ten or eleven hours. Here the oil or grease is extracted, and is collected in barrels as it flows from the bottom of the extractors.

The residue of the garbage is then drawn from the extractors, conveyed to the drying-room, and finally screened, to remove all bones, glass, rubber, etc. The final product is of a dark brown color and comparatively odorless. It is sold as a fertilizer. The following figures were obtained by our city physician, Dr. Gage, after a careful investigation of the Merz plant at Buffalo. There, from ten to thirty tons of swill are disposed of daily. The steam and power is furnished by a sixty horse-power engine, at a cost of about $5 per day. Four men are employed, at wages ranging from $1.50 to $4 daily. There are also three boys to pick out the rags, etc., and the value of the material thus picked out will pay the boys' wages. One hundred per cent of swill yields thirty-three and one-third per cent of product; about thirty per cent is in the form of a fertilizer rich in ammonia (four and one-half per cent), and sala-

ble at $9 per ton. Three per cent is fat, and is salable at current prices to soap manufacturers. There is a probable profit of about ten per cent on the investment, aside from the expense of collecting the garbage.

One practical objection to the Merz system is the price demanded for it. The company asks a city to pay something toward the erection of a plant, requires the city to collect the garbage, and also to pay for its extraction. The yearly amount paid by the city is said to pay for the operating expenses and interest on the investment. The amount derived from the sale of soap-grease and fertilizer is all profit, none of which, however, accrues to the benefit of the city. To be free from offence a plant of this character should be well constructed and intelligently operated. Some cities employing the Merz process have from various reasons abandoned it. It is certainly an expensive method for the smaller cities.

Nevertheless, there is something that appeals to all of us in the idea of extracting the valuable constituents from garbage. There is in Providence a method somewhat similar to the Merz process, but less expensive. In it naphtha is used instead of benzine, and of its practical workings the superintendent of health of that city will shortly inform us.

To destroy garbage by cremation in a furnace is a comparatively simple matter. If in addition to burning the material we try to avoid offensive odors, it is by no means a simple problem. If a garbage furnace is to be erected near dwelling-houses, it must not be a nuisance.

To fulfill these requirements a furnace should be of sufficient capacity to receive the garbage as fast as it is brought. There should be no adjacent piles of swill accumulating, and perfuming the air while awaiting cremation. To dump the refuse material into the furnace the garbage wagons should be driven into a shed which can be tightly closed while the dumping is going on. With the furnace should be connected a boiler for steam or hot water with which to thoroughly cleanse the carts after they are emptied. In addition, a garbage furnace should be thoroughly constructed, capable of standing intense heat, and be perfectly tight, to prevent the escape of noxious vapors.

A furnace supplied with all these precautions will be a marked nuisance unless some method is devised for destroying the products

of combustion which pour out of the chimney. It is essential that the foul-smelling gases formed by burning the garbage should be themselves consumed. This is done by the use of a secondary fire, over which pass the gases formed by the burning garbage.

This feature of the double fires is an essential part of the Engle Garbage Cremator. In this furnace the garbage is dumped in from above and received on a grating, at both ends of which there is a fire. Below the grating is an evaporating pan to catch the liquid drippings. By an ingenious system of dampers the flame can be made to pass above or below the garbage, and in either direction. After the combustion is once well under way, the resultant gases give forth an intense heat which is of itself a great aid to further combustion. That the second fire thoroughly destroys the odor the members of the Lowell Board of Health can testify from personal observation. There are about twenty-five Engle furnaces already in operation, from New York on the north to Panama on the south. Not only are these furnaces suitable for burning garbage, but they can be utilized for destroying infected clothing, bedding, etc., or even for burning night-soil. The Engle furnace which is the property of the New York Board of Health, is used solely for infected material. The cremators of this pattern used in our southern cities generally destroy night-soil in addition to garbage.

An Engle crematory of suitable capacity for this city could be erected for about $6,000. To run it would require one to one and a half tons of coal a day, and the services of two men. There would be no increase of expense for labor. It would mean for us simply a transferral of men no longer needed at the swill-house and dump. The cost of fuel would be reduced by the sale of ashes, which are rich in materials of a fertilizing value.

Perhaps further investigation will show that the extraction of the valuable products of garbage will be the more advantageous way, but it is certain with present knowledge that cremation is far preferable for cities the size of Lowell. Cremation is cheaper in the first cost of plant, more economical in running expenses, destroys infected clothing, bedding and furniture, and consumes garbage that is mixed with ashes. Extraction of the grease requires an expensive plant, a larger number of employees, treats nothing but garbage free from ashes and other impurities. The profit from the sale of soap-grease and fertilizer does not come to the city. The process, if successful at

all, will be so only in our larger cities. Whatever method is adopted, the plant ought to be owned and operated by the city.

To recapitulate, there is only one suitable method by which to dispose of all the garbage of a city. All refuse and waste of food materials should be gathered from the household and markets at frequent intervals. It should be removed in receptacles as nearly air-tight as possible, and conveyed to some locality on the outskirts of the city. Here the swill and other garbage should either be treated so as to extract their valuable constituents, or what is preferable, they should be consumed by fire. The method chosen should be that which gives the least offence to the neighborhood, regardless of the expense it entails. The whole process, from the collection of the garbage to its destruction, should be performed solely by the health department of the city.

Now that the ideal method of garbage disposal has been sketched, perhaps some of you may wonder how far the Lowell Board of Health practises what its chairman preaches.

Because Lowell has, as yet, been unable to adopt the best methods of garbage disposal, it does not propose, therefore, to adopt no method at all. If we cannot have the ideal method, we propose to come as near it as possible. Thus, if we cannot collect all of the garbage, we collect the greater part of it, and require the remainder to be removed in an inoffensive manner. If we cannot cremate our garbage, we can at least prevent its use as a food for cows.

In Lowell all swill from private houses is collected three times a week by the health department, and is conveyed to a swill-house on the outskirts of the city, where it is purchased by farmers at twenty-five cents a barrel. There is seldom any swill left over at night. If any remains, it is conveyed to a farm and buried. Every night the swill-house is thoroughly cleansed, and is kept sweet and clean. Owing to an insufficient force of men and teams the swill from hotels, restaurants and the large mill boarding-houses cannot be collected by the city. It is removed by licensed collectors. To obtain a license, an application, accompanied by five dollars, is made to the Board of Health. On each application is a list of places at which the applicant intends to collect swill. These places are visited by an inspector, to be sure that they are not private houses. The license is revokable at the pleasure of the Board of Health. Among the con-

ditions of the license are the following: that the licensee shall not permit any swill collected by him to be fed to cows, and that he shall permit his premises to be inspected by the Board of Health at all times. The license is never delivered to the applicant until he has brought to the superintendent for approval his swill-wagon, containing a suitable water-tight covered box or barrels. With these precautions, the swill is collected from our hotels and restaurants in a manner almost as unobjectionable as that in which the health department collects it from private residences. The farmers who purchase swill at the swill-depot have to subscribe to the same conditions as do the licensed collectors.

The methods of collecting the swill of Lowell are quite satisfactory, but those of its disposal cannot merit praise. As we have no method of destroying our garbage, it is used as a food for animals, and all the Board of Health can do is to see that the food is reasonably fresh and is not fed to the one animal so necessary to human welfare — the milch cow.

When the present Board of Health of Lowell entered upon its duties a few years ago, there was no penalty against feeding swill to cows, and a farmer could use this kind of diet for his cows, provided the milk was found, as was often the case, above standard. All that could be done was to control the ultimate disposal of our swill by selling it only to farmers who would agree not to feed it to cows and who would permit the Board of Health to inspect their premises. Of course some few men violated this agreement, but were sooner or later found out by our inspectors and thereafter were not allowed to obtain swill in Lowell. As a result of these inspections several farmers had to go out of business, and sold their cows at a loss. Others found such a profit in this disgraceful occupation that they went long distances to other cities for the swill they could not obtain in Lowell.

We have thus restricted the use of swill, but still more remains to be done. We cannot dispose of the refuse from markets. Unfortunately, it is smuggled on to the dumps after dark. We cannot, with all our care, prevent the swill-house from attracting flies and producing some slight odors. Lastly, we cannot prevent the use of swill as a food for pigs.

In order to do away with swill-house garbage on dumps, and feed-

ing to swine, we have twice recommended cremation of garbage to the city government. We hope soon to make a third request, and trust that it may be granted.

Dr. CHARLES V. CHAPIN, Superintendent of Health, Providence, R.I.

I wish to express my satisfaction at this time with the thoroughness with which the subject has been treated by Dr. Field, and I heartily endorse his views, that different towns require different methods for the disposal of garbage. In regard to my own city, Providence, the feeding of garbage to swine and cattle had been in vogue for many years, and I was heartily disgusted with it. The pork from the swill-fed hogs was flatly refused by all local butchers.

Within a few months a new process of garbage disposal has been adopted. It consists not in the destruction of the garbage, but in the utilization of all its valuable ingredients. The process is as follows: The garbage, as soon as discharged from the collecting-wagons, is put at once into the "extractors." These are large wrought-iron tanks, six feet in diameter and eighteen feet long. After they are filled the cover is screwed down, and is not again removed till the process is completed. By means of an arrangement of pipes within the extractor, by which applications of naphtha and steam are made to the garbage, the material is completely dried and the grease extracted at the same time. The details of this operation are its essential features, and the process is a secret one. All the foul odors of the garbage are condensed into a small volume of water, which is, after all, not very offensive, and could readily be discharged into a sewer or small water-course. The only odors which can be a nuisance are those arising from the unloading of the garbage-wagons for the treatment of the garbage itself, which is conducted in perfectly air-tight tanks and pipes.

The grease obtained can be used for any purpose for which dark, cheap grease is applicable. The solid residue, called tankage, is valuable as a fertilizer to mix with phosphate rock.

I am satisfied that both this process and cremation could be conducted without any great nuisance, but neither should be carried on in thickly settled business or resident portions of a town. The trouble is in unloading the swill from the wagons and putting it into the "extractors" in the one case, or the furnaces in the other. The

success of either process, so far as freedom from nuisance is concerned, consists in strict attention to details.

As to the pecuniary advantage of the Providence system, it must necessarily depend largely on the local cost of fuel and the value of fertilizers and grease, all of which vary greatly in different places. In most cities, I think the Providence system would prove the best.

SEWAGE AND SEWAGE DISPOSAL,

WITH A DESCRIPTION OF THE SEWAGE WORKS AT WORCESTER, MASS.

BY PROF. LEONARD P. KINNICUTT, OF THE WORCESTER POLYTECHNIC INSTITUTE.

(Read at the meeting held at Worcester, Oct. 15, 1890.)

WHEN six weeks ago your Secretary did me the honor of inviting me to read a paper before you on the treatment of sewage, I accepted with many misgivings.

The subject is so large, and so many things might be said, that I felt I had not the time at my disposal to make a properly condensed paper, and the paper which I have the pleasure of reading to you this afternoon, has, I am afraid, many faults of omission and commission.

I have tried, however, to make it merely an outline of the various methods used for the purification and clarification of sewage.

Sewage, says Professor Drown, is the water supply of a city as it passes off. A more complete definition is that given by Dr. Tidy, that sewage is the refuse of communities, their habitations, streets and factories. A large proportion of the most offensive matter in sewage is human excrement and urine, but mixed with this, there is water from kitchens, containing animal and vegetable matter, the drainage from stables, and further, the drainage of factories, containing all the waste products that are there produced. Sewage is not, therefore, human excrement diluted with water, but water polluted with a vast variety of matters, some held in solution, some in suspension.

Sewage is a very variable substance. It differs in composition in different cities, and in the same city at different times of the year and day; that flowing at night has fewer solids in it than that flowing by day. The sewage of a manufacturing city is of a very different character from that of a residential town, and its constituents in a manufacturing city like Lowell, which is chiefly engaged in one branch of industry, are very different from those in a city like

Worcester, where the industries are varied. We can not, therefore, speak of normal sewage, or say how much organic matter sewage will on the average contain; roughly speaking, however, sewage of cities or towns contains over sixty grains of solid matter in one United States gallon, a little less than half of which is organic matter. More than one-third of this solid matter is dissolved in the water, the remainder being suspended. Sewage also contains as a rule more than five grains of combined chlorine in a gallon. But each town and city turns out a special type of sewage, whose nature, effect, and proper mode of treatment can only be determined by careful examination and experiment. A method of treatment that might be successful in one place might fail in another.

All sewage, however, contains organic matter rich in nitrogen, and has one common property, that of decomposition. Fresh sewage has very little odor, and gives no more offense than fresh kitchen refuse, but within forty-eight hours decomposition begins, and not only are odors of a most offensive nature given off, but substances are formed which serve as nutriment for those low forms of animal and vegetable life which are considered especially dangerous to human beings. The proper removal and disposal of the refuse of a city is, therefore, a question of the first importance.

This was recognized in very early times, and the sewage works of Rome nearly equalled in magnitude those of its water supply. The most notable example of these ancient sewers is the Cloaca Maxima, built about 600 B.C., which has defied the vicissitudes of more than twenty-four hundred years, and is still used for the purpose for which it was built.

During the wars and political disturbances that followed the fall of the Roman Empire, sanitary science was neglected and allowed to pass into decay, and it was not until the beginning of the present century that the removal of sewage from cities received any serious consideration.

The first method used for the disposal and purification of sewage was, undoubtedly, what may be called the water carrier and purification system. This may be defined as carrying the refuse of towns and cities through drains to a stream, river, arm of the sea, or to the ocean. The theory of the process is, that if sewage is greatly diluted with water the oxygen dissolved in the water will indirectly burn and destroy the organic matter. This method is still the common one

everywhere except in England, and its merits and demerits can be ascertained by seeing how it has worked in a large number of cases, under varied conditions.

From investigations that have been made it seems that when the volume of an untidal river is much greater, say thirty to forty times the volume of the sewage, and when the current of the river is over one mile per hour, for a distance of four or five miles from the point where the sewage enters the river, sewage can thus be disposed of without causing any offense.

These conditions, unfortunately, do not occur as often as might at first be supposed. A stream may usually have sufficient water to dilute a sewage discharge, but during the hot summer months it may be found to be insufficient. The current of the river may average over one mile per hour, but have places where there is slack water in which the decomposable matter settles.

As illustrations of this method of disposal, I will cite the following examples: Boston sewage was formerly discharged on its shores at the head of docks; the dilution was very much greater than thirty fold, but there was seldom any current, and solid particles settled in masses, giving off most offensive odors. Now, the sewage of the city is all discharged into a good current in the harbor, and only a very slight nuisance is produced. Providence discharges its refuse into the bay where there is no current, and so much of a nuisance follows that they have decided to purify the sewage by chemical precipitation. Worcester sewage ran into the Blackstone, a stream whose volume is on the average only five times greater than the volume of the sewage, and I do not think it is necessary to dwell on the condition of that stream. The bulk of the sewage of Lawrence is discharged into the Merrimac river where there is plenty of water and a good current, and no trouble has ever been experienced. Sewage discharged into the Mississippi is rapidly oxidized and carried off. The Amazon river might possibly take care of the sewage of the world.

When sewage can properly be emptied into water, this method is generally found to be the best and cheapest. Unfortunately, as we have seen, it can not often be used with safety, and other means must be employed. The small area, great density of population and multiplicity of manufactories in England, combined to produce in that country the most extensive pollution of natural waters, and it

was consequently there that public opinion first demanded a solution of the problem of sewage purification, and the various methods which I shall mention, originated there.

THE MIDDEN SYSTEM.

Under the name of the Midden system I include the methods which have been devised to collect human excrement, including urine, separately from the other refuse of a community.

The amount of fœcal matter voided by each person daily, averages a quarter of a pound, twenty-five per cent of which is solid matter. One thousand persons would therefore yield sixty-two and one-half pounds of dry fœcal matter per day. The daily amount of urine per person is in the neighborhood of three pints, containing two and one-half ounces of dry solid matter; for one thousand persons this equals one hundred and fifty pounds per day.

A community containing one thousand persons would void in a year, 77,462 lbs. or 34.6 tons of dry solid matter, of which 58,315 lbs. or 26 tons is organic matter, which undergoes decomposition.

The first method used to prevent this large amount of organic matter from causing a nuisance was to collect it in cesspools. There are so many and such great objections to the cesspool that its use has been prohibited in almost all cities. Among these objections may be mentioned, the obnoxious and dangerous odors given off, the danger of polluting neighboring wells, and the difficulty of removing the contents, as must be done from time to time.

An improvement on the cesspool system is the pail, or what may be called the temporary cesspool system. A simple tub or pail is placed under the seat of the privy, to collect all the excretal matters. These pails are collected every day by contractors and their contents used for manure. This system has been, and is now, used in many large cities to a greater or less extent, as for example Edinburgh, Glasgow, Paris and other continental towns. There is no doubt that this system is more healthy than that of having large cesspools in the vicinity of human habitations.

It necessitates only a pail with or without disinfectants, and a system of carefully regulated collection. The advantage of the plan is that the collection must be carefully looked after, for if the refuse is allowed to remain too long, it immediately makes itself known by offensive odors. I do not think the pail system should ever be intro-

duced into cities; but for small towns unprovided with sewers, much may be said in its favor.

The Liernur or Pneumatic system is an outgrowth of the pail system. In this, the human excrement and urine are removed from their receptacles and drawn through air-tight iron pipes to a central reservoir, by means of a vacuum, caused by an air-pump, the contents of the reservoir being emptied each day into hermetically closed tanks and carried into the neighboring country to be used as manure.

Two varieties of closets are used in the Liernur system. That for the better classes is flushed by a mechanical device, with a very small amount of water, the quantity being limited to prevent dilution of the fœcal matter; that for the lower classes has no movable mechanism, and is used without water. The hopper is so arranged that the fæces fall directly into a trap without touching the sides. The trap always remains full and overflows by gravity into the soil-pipe, while the odors arising from the trap are made to pass through a ventilating pipe into the outer air.

The Liernur system is only for the removal of human excrement, and not for the removal of other refuse matter, such as sink drainage and street washings. In Holland, where a general system of sewage like that employed in the large cities of this country can not be introduced except at an enormous cost, on account of the lowness and flatness of the country, the system may possibly be worked to advantage, obviating the trouble and dirt involved in the pail system.

The dry-earth system is another plan that has been adopted for the separation of human excrement from sewage.

The disinfecting power of earth has been known from very early times, but this knowledge took no practical form in Europe as a health measure until 1858. In that year the Rev. Henry Moule, the vicar of Fordington, believing that much of the ill health in his parish was caused by cesspools, experimented on the deodorizing power of earth and invented the earth-closet.

In its simplest form the earth-closet consists of a pail containing a little earth, placed under the seat of the privy, a box of dry earth being kept in the privy, about one and one-half pounds of which is added to the pail after each visit. There is thus formed a consolidated and inoffensive deposit. When the pail is full it is removed, and after being thoroughly dried by being allowed contact with air, in suitably built sheds, can be used again in the closet. The same earth can be

used certainly three times without giving offense. Its value is even then very small, being only equal to rich garden soil. The best earth to use for this purpose is clay, and sand is the worst. Ashes can be used, but their deodorizing power is much less than that of earth. Charcoal has also been used; its deodorizing power is much greater than earth, and the amount required is only about a quarter as great, but the original cost is much greater. With the earth-closet, disinfectants can be used when considered necessary.

This system would, I believe, work very well in small villages and towns, when well looked after, and it could be easily introduced. In very small villages, each house-owner could easily be taught the proper method of preparing and taking care of the earth. In large villages, the closets could be taken care of by paid scavengers, who would remove the contents and supply fresh earth. If once introduced, it would certainly be a great improvement over the common method of cesspools, which is, as we all know, a constant source of danger.

The advantage of the various forms of the Midden system is, as we have seen, that a large quantity of organic matter, of a kind which is believed to be most injurious to health, is kept out of sewage by excluding human excrement from it.

I know that high authorities state that the sewage of towns in which the Midden system is used is almost identical with that of water-closet towns; but this, I think, rests on very doubtful experiments, and I believe that a much less dangerous sewage would result if human excrement were excluded. Still it would be a very brave man, who would at the present time advise a city to provide itself both with a Midden and a water-carriage system.

WATER-CARRIED SEWAGE.

There are three methods now in use for the purification of water-carried sewage:

Surface or broad irrigation.

Intermittent downward filtration.

Chemical precipitation.

You may notice that I do not mention any form of straining the sewage, as a method of purification. Sewage cannot be purified in this way.

A great number of processes have been tried, using a variety of

substances for the straining material, among which may be mentioned hay, charcoal, ashes, dry earth, sand, and iron slag, and all have been failures. For if the straining material be of too fine a texture it soon clogs, while if it is too coarse, the organic suspended matter is not removed. Any process that depends merely upon straining as a means of purification, is to be condemned.

SURFACE IRRIGATION.

This method was based on the assumption that all the offensive and decomposable substances held in suspension and solution would be absorbed by the soil and taken up by the growing plants, while the effluent sufficiently purified, would pass away into drains, and could be allowed to enter streams and rivers without fear of pollution.

That such a purifying process does take place, may be seen by the simple experiment of pouring a little sewage on a flower-pot filled with earth: the water which oozes out, if not too great a quantity of sewage has been used, will be found to be freed to a great extent of its disagreeable odor.

This system is known under the name of the Sewage Farm system. The sewage is brought to the highest points of the land to be irrigated, conveyed by carriers of a more or less permanent character into some form of sewer channels. These open carriers or surface channels can be mere trenches, and the land more or less flooded by the carriers being dammed up at certain points. The land must of course be so levelled and drained that the sewage will flow over different portions of the ground, and not into hollows, where it would soon become stagnant, or pass away without undergoing the needful purification.

The advocates of this system claimed that the process not only purified the sewage, but that the plants would absorb and assimilate the organic matter of the sewage. Or in other words, here was a process by which the land would be so enriched that the crops obtained from the land would more than pay the expense of purifying the sewage. Enthusiasts full of faith were found to embark in private sewage farms, but it was not long before an unpleasant awakening occurred; it was found that sewage farms were commercially a failure.

The failure can be easily understood, if, as Dr. Tidy well puts it,

we consider that the sewage farmer was compelled, if the sewage was to be purified, to take it at all times, day and night, Sunday and week-days, winter and summer; to take it whether his crops needed it or not; to take it in seed-time and harvest, in wet weather and in dry. Nay, just when the rain is most plentiful, and moisture the least needed, the sewers pour out an increased volume, which must be admitted to the land.

Without going further into details I will only say that it is now universally conceded that no profit can be expected from the cultivation of crops on a sewage farm.

Allowing this, can the system of broad irrigation be used successfully for the purification of sewage? I believe that there is very little question that under favorable conditions, and with certain kinds of sewage, this method of purification is very efficacious. Let us consider for a moment what the favorable conditions are. The first essential is a large plot of land. If, in the experiment with the flower-pot, too much sewage had been added, the water draining out at the bottom would be as impure as the sewage itself. So on a large scale, if too much sewage be added to a plot of land, the sewage will not be purified. Experiments have shown that the smallest amount of land allowable is one acre to one hundred persons, or for a city of the size of Worcester eight hundred acres would be necessary. The land must be at some distance from the city supplying the sewage, and should not border on any populous district, for I do not suppose there was ever any irrigation field which did not in summer give off a loathsome odor. The kind of soil is also a consideration; if it is too open and porous, the sewage passes quickly through it, and emerges scarcely, if at all, purified. If, on the other hand, it is too compact, the water cannot escape, and the soil is rendered swampy. Finally, it must be remembered that all kinds of sewage are not fit to be applied to cultivated land. If there is a large proportion of industrial refuse, such as acids, metallic salts, dye and tan liquors, the sewage will injure or destroy the crops, and may completely sterilize the land.

These difficulties, and the expense of obtaining large areas of efficient land, suitably situated, soon showed that the method was not a practical one for the majority of large cities. The land difficulty must, at least, be overcome, if the system was to be universally employed. The outcome was the development of the intermittent downward filtration.

This system is due to experiments made by Dr. Frankland, of England. It differed from the irrigation system in having the land deeply under-drained, and by applying the sewage intermittently. The soil being drained at a depth of six feet or more, allowed a considerable distance for percolation, and this constituted filtration as opposed to irrigation. The land becomes an indirect oxidizing instrument to burn the impurities, and so transform them into harmless gases, rather than a mere separating or filtering machine.

To obtain the best effects of oxidation, and to keep the land in the most effective condition, the sewage was to be applied intermittently; i.e., with regular intervals of rest, to give time for the air to go into the ground as the water runs out, thus fitting it for a fresh dose of sewage. This constituted the intermittent filtration.

This intermittent action, it was claimed, would avoid clogging the soil and secure its frequent aeration. By such means, it was stated that the sewage of 3,300 persons could be applied to one acre of ground, and perfect purification of the sewage would result. To illustrate the working of the intermittent filtration system, let us imagine a population of 9,900, with three acres of suitable land drained to a depth of six feet. Each acre is sub-divided into four parts, for the purpose of the work; the sewage of 3,300 persons being placed successively on each quarter acre for a period of six hours, eighteen hours being allowed for aeration before it receives another dose. It was allowed that this process involved the sacrifice of the manurial value of the sewage.

This system has received most careful consideration from sanitary men, and it is with this system that extended experiments have been made by the Massachusetts Board of Health at Lawrence. Their report on the subject is now in press, and will appear before many months. Therefore it is not yet time to discuss the method at any length. From what I know concerning the work, however, I believe their experiments will show that domestic sewage — sewage that does not contain refuse from manufactories — can be sufficiently purified to enter a river not used as a water supply, by intermittent downward filtration through carefully prepared beds of sand, and that the sewage of about 1,500 persons can be thus purified on one acre of coarse mortar sand. Their report will also show that the purification does not depend in any way on the removal of organic matter by what we call filtration; that is, mechanical separation, but is due to living

organisms called bacteria, which require free oxygen for their growth. That if the bacteria are not present the purification ceases. The sand filter must therefore be continually supplied with air, and the filtration must be intermittent, so as to allow the air to run in as the water runs out.

The filter beds of sand have now been used for over three years, and their action is as good, if not better, than during the first year; or, in other words, there appears to be no filling up of the air spaces between the sand. With domestic sewage, their experiments have been most successful. These experiments, however, have been made only with domestic sewage, and do not prove anything as to what would take place with sewage containing acid liquors, iron salts, wool waste, and the refuse from tanneries and other manufacturing processes. Could the bacteria live in such sewage and do their work? Would there not be great danger of the spaces between the sand particles becoming filled up, which would not only make the sewage penetrate the ground less readily, but would also retard the entrance of air; and the work of the bacteria depends on their being supplied with oxygen that is in the air.

I have now considered the two systems of purification of sewage by earth treatment, but before I speak of chemical precipitation, I would like to say something as to the hygienic effect of such treatment. The discussion of this question would, however, occupy too much of your time, and I therefore pass directly to the consideration of the next process — chemical precipitation.

Chemical precipitation means the addition of certain chemicals to the sewage, whereby the solid suspended matter and part of the matter in solution is precipitated, and a more or less general deodorization of the offensive constituents, — both those precipitated and those remaining in solution, — is brought about. In this process the sewage from which the grosser matters have been removed is treated with certain chemicals, either suspended in water, or, if soluble, dissolved in water. After such treatment the sewage is run into subsidence tanks, where it is either allowed perfect rest for a few hours, or is passed slowly through a series of tanks. In both cases the precipitation takes place, and the clear liquid, or the effluent, as it is called, is then either allowed to run directly into a water-course, or over a small area of land. The precipitate, known under the name of sludge, is removed from the tanks, and is treated and disposed of in various ways.

The processes for the chemical treatment of sewage are so numerous — I believe that about four hundred and fifty patents have already been obtained — that even a casual mention of each is clearly impossible in the time I have at my disposal, and as the processes differ from each other mainly in the kind of chemicals used, I will restrict myself to mentioning two of the best-known processes, and then point out certain details of treatment essential for the success of any precipitation process.

When lime is added to raw sewage, if the sewage is acid, which is often the case in manufacturing towns, the lime neutralizes the acid, and then carbonate of lime is formed. This salt is insoluble and is heavy, and if the opportunity is offered, the light, flocculent suspended matter in the sewage will be carried down with the precipitated carbonate. In addition to this a certain amount of dissolved organic matter is also precipitated, the lime forming with the organic matter a compound of varying chemical composition.

Salts of aluminium, as alum, have what is called a great affinity for organic matter, and it is on this account that these salts are used as mordants in dyeing. When they are applied to cloth fabrics, they unite with the coloring matter of the dye, which is in solution, and form insoluble compounds on the cloth. This property holds good for the organic matter in the sewage, as it does for ordinary colors used by the dyer or printer. If a solution of crude alum is thrown into a slightly alkaline sewage it is decomposed, a basic sulphate of aluminium is formed which combines with the greater part of the organic impurities, forming insoluble compounds which are precipitated. Aluminium salts, it is believed, have not only the property of precipitating dead organic matter, but also that of removing to a great extent the germs of disease.

The combination of these two salts, lime and alum, was first suggested by Anderson, of Coventry, England, and the process in which they are used is known as the Coventry process. In my opinion this is the best and simplest of all the precipitation processes. It is the one which is used in Worcester, and I shall refer to it again when I speak of Worcester sewage.

The second process is the A. B. C., which consists in adding charcoal mixed with clay and a little blood or other glutinous substance capable of coagulation, and then sulphate of aluminium. No lime is added unless the sewage is decidedly acid. The addition of the char-

coal and clay, it is claimed, arrests all offensive odors, no matter how foul they may be, and the aluminium sulphate acts in the way I have already mentioned.

This process is more expensive than the Coventry, and for the treatment of manufacturing sewage I do not believe it is as successful.

In all precipitation processes, as I have already said, certain details of treatment are essential. The most important of these are the following: —

It is necessary that sewage should be treated when fresh. By fresh sewage is meant that in which active fermentation has not taken place. Speaking generally, the sewage should not be more than forty-eight hours old for effective precipitation, and undoubtedly better results could be obtained with a smaller amount of chemicals when the sewage is only twenty-four hours old.

It is essential that a sufficient amount of chemicals should be used to effect complete precipitation. No greater mistake can be made than to try to save expense on the chemicals, and because this has often been done, the failure of the precipitation process has followed.

One most important essential for the success of the process is sufficient tank accommodation. This is necessary for two reasons: First, that the precipitate may subside perfectly, leaving a clear effluent. If the tanks are too small the sewage will be forced too quickly through them, and this would mean imperfect subsidence of the precipitate. Second, sufficient tank room is necessary, so that the precipitate or sludge may be frequently removed, otherwise the freshly precipitated sewage may be contaminated by the decomposing materials of a previous precipitation. Many a good effluent has been spoiled by foul materials being allowed to remain in the tanks. These materials undergo decomposition, and the gases given off contaminate the effluent.

Using these precautions, what kind of an effluent can be obtained?

My own opinion is that it depends greatly on the character of the sewage treated. If the sewage contains large amounts of metallic salts, with more or less free acid — sewage, for instance, like that of Worcester or any other large manufacturing town — I believe that by using the Coventry process, a clear, odorless effluent can be obtained: that the effluent will contain no suspended matter, and less soluble organic matter than the sewage, and that the organic matter it does contain in solution will, when allowed to flow into a stream whose

volume is from five to ten times greater than the effluent, or allowed to flow on a very small area of sand, be quickly oxidized and destroyed without causing any nuisance.

But before we can decide on the success of the process we must remember that we have the sludge containing the organic decomposable matter of the sewage, still left on our hands. Can the sludge be disposed of so that it will not become a nuisance?

The sludge, as it can be obtained from the tanks, is a slimy mass containing more than ninety per cent of water. It has no commercial value, and I believe the only proper method of treatment at the present time is by fire. This is not so difficult as might be supposed. The sludge can be taken from the tanks to a filter press, where the amount of water can easily be reduced to fifty per cent. and the slimy mass be changed to a solid cake, without odor, and easily handled. Furnaces have been constructed for burning these cakes, and the amount of fuel necessary for the complete destruction of the organic matter is very small. A furnace similar to the one which all cities should own for the destruction of city garbage can be employed, or one and the same furnace can be used for both purposes.

We have seen that a clear effluent can be obtained, and that the sludge can be disposed of without any nuisance being caused; then it may be asked why chemical precipitation has sometimes been a failure. I believe this not to be the fault of the system, but the fault of the way the process has been worked. We have here a process which needs constant, intelligent oversight, just as much as a process of chemical manufacture, and instead of being a process of manufacture it is one of destruction, where in place of money being gained by the improvement of the article manufactured, there is a gain by lowering the standard of the work done. Consequently there is a constant temptation to do poor work, to save chemicals, to neglect looking after the tanks, which, when yielded to, results as all such work must, in making the process a failure instead of a success.

Until a year ago the three processes which I have mentioned were the only ones which had received any attention from sanitary engineers. Last summer a new process was brought to their attention by Dr. William Webster, of England, and though it has not as yet been tried on any very large scale, still on account of its novelty and theoretical correctness, it deserves mention. This process is known as electrical decomposition of sewage. It depends on the fact that

the water and salts, like chlorides and sulphates, which occur in the sewage of all manufacturing towns, are decomposed by a current of electricity. The oxygen, chlorine and sulphur trioxide, which are formed by this decomposition, are given off at the positive pole, and being just liberated from their combinations, are in their most active state, and rapidly oxidize and burn up the organic matter which is in the sewage, odorless and harmless gases being formed. The beauty of the process will be recognized if we remember that the three strongest reagents that the chemist can use in his laboratory for destroying organic matter, are just the three that are here produced in the sewage itself; that we are not obliged to add any chemicals to the sewage, and that the amount of sludge is reduced to a minimum.

The process has, however, not been carefully enough investigated to allow an opinion to be formed as to its practicability on a large scale.

This completes my classification of the methods used for the disposal of sewage, and I venture to submit my own conclusions regarding the various methods; but not wishing you to think for a moment that my opinion is the settled opinion of sanitary engineers,— for the purification of sewage is still in an experimental state, and experts disagree widely as to the value of the various processes.

The Water Purification System. For cities situated on the sea or on large and rapid rivers, this method affords the most economical and efficient means of dealing with their sewage.

Cesspool System. Cesspools should not be allowed in any city, town or village.

Pail System. The pail system affords an efficient means for the disposal of the worst organic substances, in villages or towns which have no sewage system.

The Liernur System. This system can not be recommended for any New England city.

The Earth-closet. This I consider preferable to the pail system, and should strongly advocate its use in small villages and towns.

Broad Irrigation. — Sewage Farming. This method for the purification of sewage can not be recommended for the great majority of cities. I admit that in certain places it may be successful, as in Berlin, where there is a large sandy area of twenty-six square miles, not more than twelve miles from the city; but I believe that purification of sewage by the sewage-farm system as carried out in England, should not be introduced into this country.

Intermittent Downward Filtration. The system as first proposed by Dr. Frankland, can not be recommended, but it seems probable that, using carefully prepared filter beds, this system may be considered in the future as the best method of treating the sewage of towns and cities whose sewage is of a residential rather than of a manufacturing character. For sewage which contains large quantities of manufacturing refuse, it certainly can not be recommended at the present time.

Chemical Precipitation. This method is, at the present time, the most satisfactory known way for the disposal of sewage containing large amounts of acid, mineral salts, and refuse from factories. A sufficiently pure effluent can be obtained to run into a stream not used as a water supply, or to be run over a very small area of land. The sludge obtained can be pressed and burnt without causing offense.

Electrical Decomposition. At the present time no opinion can be formed in regard to its practicability.

In conclusion, I wish to say a few words about Worcester sewage. When Worcester was at last compelled to take the sewage question into serious consideration, Mr. Allen, our most efficient City Engineer, was requested to study the question and make a report. He made a careful examination of the various methods, visiting England and the Continent for this purpose, and after consultation with experts both in this country and in Europe, reported, as I think, correctly, that the best system for Worcester was the chemical precipitation process.

As regards the plans and the work done, full details may be of interest. All the sewers of the city enter Mill Brook, which empties into the Blackstone at Quinsigamond village. The minimum flow of Mill Brook is about 2,000,000 gallons, and its maximum flow at least 50,000,000 per day, while the normal flow of Worcester sewage is between three and four million gallons per day. For any system of sewage purification, therefore, some means will have to be devised to carry the sewage to the purification works without allowing it to mix with the water of Mill Brook. After a careful study of the problem, Mr. Allen has recommended the building of a separate conduit for the waters of Mill Brook, and working plans are now being made.

At the present time three or four million gallons of the sewage and water of Mill Brook are diverted from their course by a gate-way at

Quinsigamond village, and carried to the precipitation works. In this way, in the hot summer months, when the brook is in its most offensive state, over two-thirds of its total flow is subjected to chemical treatment, while in wet weather, when the brook is in a much better state, only one-tenth of the flow is taken to the works.

The works consist of a boiler and engine house, a mixing-room for the chemicals, precipitation tanks, sludge well, etc., so arranged that their capacity can be easily doubled.

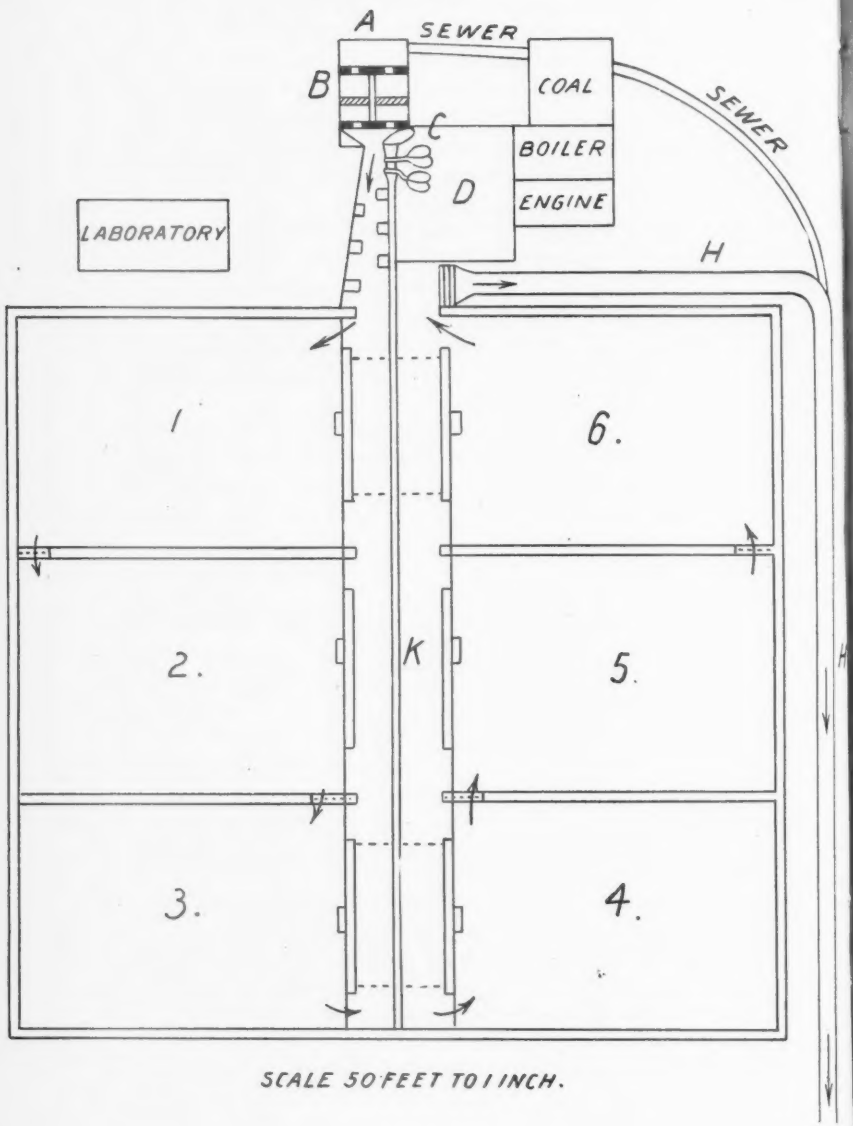
Reference to the drawings I have placed before you may make the arrangement more easily understood.

The sewage is brought by the outfall sewer A to the gate-house B, which is divided into two parts, each part containing an iron screen. The gross matters in the sewage are thus removed, and by means of gates the sewage can be carried through either part, allowing a continuous flow while the screens are being cleaned. From the gate-house the sewage runs through the channel C to the tanks. From this channel, by means of a small pipe, a little of the sewage is carried into the mixing-room D, where there are four mixing tanks, two for the lime and two for the alum. The mixing and dissolving of the chemicals is aided by mechanical stirrers run by steam, and the lime and alum, which after this treatment are partly in suspension, partly in solution, are carried back by pipes into the channel C. This channel is furnished with baffle plates made of wood, and the fall being about one foot, the chemicals become thoroughly mixed with the sewage.

The sewage then enters the precipitating tanks; these are six in number, made of brick, with concrete floors one foot in thickness. They are each 66 feet long, 100 feet wide, and 6 feet in depth, — the total capacity being 1,500,000 gallons. They are so arranged that they can be used intermittently or continuously, and for the purpose of removing the sludge and cleaning the tanks, any one can be shut off from all the others.

The sewage enters the tank marked 1, and from there flows to 2, 3, 4, 5, 6, the flow, however, being so slow that on looking at the tanks when filled, very little movement of the water is noticed. The time required for any given volume of water to pass through the six tanks will be about six hours, thus allowing full time for complete precipitation.

The clear effluent passes over a weir at the end of tank 6, and falls



SCALE 50 FEET TO 1 INCH.

over stone steps into the effluent channel H, which conducts it to the Blackstone River. Provision is also made, however, for removing the clear effluent from any one of the tanks. The concrete bottom of each tank inclines to the centre, where there is an opened drain; these drains are connected with the sludge-pipe K, which carries the sludge to the sludge-well L. Here the sludge is raised fifteen to twenty feet by means of a pump, and is conducted by a pipe to a sandy plot of land having an area of about twelve acres. For the present the sludge will be placed upon this land, and from time to time is to be covered with sand. This will answer for the present, but a time will soon come when it must be pressed into cakes and burned.

The sewage as it now comes to the works varies greatly from hour to hour, sometimes containing large amounts of acid liquors and iron salts, and at other times being nearly neutral, and containing very little mineral matter. Tests are made every five minutes during the day and night to determine roughly the amount of acid liquors and iron salts present, and by these tests Mr. Arthur Forbes, who is in charge of the works, and to whose intelligent oversight their successful operation is due, decides the amount of lime and sulphate of aluminium that is to be used. At times it is necessary to add 120 grains of lime to a gallon of sewage; at other times the amount is reduced to two or three grains. On the average, about two tons of lime are used each day. The amount of sulphate of aluminium added also varies very greatly, depending on the amount of iron salts present in the sewage. Very often the amount of iron sulphate present renders the addition of aluminium sulphate unnecessary. The average amount of aluminium sulphate used each day is about two hundred pounds.

As is to be expected, most of the sludge is found in the first basins; the first and second basins are cleaned every thirty hours, the third every three days, the last basin every two weeks. As has been explained, this sludge, which at present contains over 98 per cent of water, is carried from the sludge-well by a pipe-line to the large sludge basins. The water gradually sinks into the sand, and at the end of eight days the sludge contains only about 80 per cent of water, and can be easily removed by shovelling. No odor is to be perceived at the sludge basins, which is undoubtedly due to the amount of free lime contained in the sludge.

As regards the sewage, effluent and sludge I cannot at the present time present any tabulated analytical results, but the analyses I have made show that, with Worcester sewage, chemical precipitation does much more than simply precipitate out the suspended matter.

The total amount of soluble matter in the effluent is twenty per cent less than in the raw sewage, and the volatile matter is reduced from about sixteen parts in 100,000 to nine parts, and the albuminoid ammonia from eight-tenths of one part to about three-tenths. The effluent has, I think, been brought to such a state of purification, that while it would not be allowable to run it into a stream used as a water supply, it is sufficiently pure so that the organic matter which it still contains will be easily destroyed without causing any nuisance, when it is run into the Blackstone River.

Remarks of T. M. Drown, on Professor Kinnicutt's paper.

Mr. Chairman and Gentlemen: — I have listened with great pleasure and interest to Professor Kinnicutt's paper, which has presented the subject of sewage purification, both from the standpoint of historical development and of adaptation to special needs, in a most admirable way.

The idea once prevalent that it was an economic duty to utilize the manurial value of sewage on the land is now giving place to the more sensible notion, that it is a sanitary duty to get rid of sewage as quickly as possible.

There is no doubt that the simplest method of disposing of sewage is to pour it into the nearest water-course, or into the sea, and this is also the best method where it can be done safely.

In the case of a stream two considerations enter the problem: First, Is the water of the stream used for drinking below the point at which the sewage enters? Second, Is the volume of sewage entering the stream large enough in proportion to the volume of the stream, to make the water offensive to the sight or smell, or to injure the water for manufacturing purposes?

That the water of a sewage-polluted stream is not fit to drink may be assumed at the outset. It is true that in the case of large rivers, like the Mississippi, the Hudson, the Merrimac, sewage-polluted water does form the supply of some large cities. Immunity from

harm is supposed to be obtained in such cases by the very great dilution of the sewage, and also in consequence of the "self-purification of streams"—a consoling expression which had its origin in the days before we knew anything of micro-organisms and their power of producing disease.

But when a stream is not used for drinking water it may properly receive the drainage of the towns on its borders to an extent that will not make the stream a nuisance, or prevent its use in boilers, or for manufacturing purposes.

In Worcester this limit has been far overpassed, and the water of its river resembles sewage much more than the water of the lakes in which it had its origin. The question here in Worcester was not to take the sewage out of the river that its waters might be used for drinking, but simply to prevent a nuisance. And any process that will do this most cheaply and simply is clearly the one to adopt. It seems to me that the process of chemical precipitation selected will, when the system of sewerage is complete, and all the city sewage is treated by chemicals, do what is expected of it.

As most of you know, the State Board of Health has been carrying on experiments at Lawrence for the last three years in the purification of sewage by intermittent filtration. The purifying power of porous soil on organic matter, whereby it is completely oxidized, has long been known, and the sewage farms so general throughout Europe for the combined purification and utilization of sewage are instances of the application of this well-known principle.

But it is safe to say that never has there been a systematic and comprehensive series of experiments on the purification of sewage by intermittent filtration that can compare with those which have been in progress in Lawrence under the direction of Mr. Hiram F. Mills, the engineer member of the Board of Health. The report of the work of the Lawrence Experiment Station is now in press and the results obtained will shortly be available to all. I will merely say in this connection that it has been shown that sewage may be continuously purified by simple filtration through sand at the rate of 100,000 gallons per acre a day (and even higher rates have been obtained), and yield an effluent that is purer, organically speaking, than many well-waters in general use.

But this statement does not convey the idea of the real importance of the Lawrence work, which is mainly directed to determining the

conditions of successful purification of sewage by its disposal on land. For this purpose it is necessary to determine by actual experiment the unfavorable conditions, that money may not be wasted in installing plants for sewage purification on land unsuited for the purpose.

There have also been carried out at Lawrence by Mr. Allen Hazen a very thorough series of experiments on the chemical precipitation of sewage, which exceed in accuracy anything heretofore attempted.

I would in conclusion like to express my thanks to Professor Kinnicutt for his instructive paper, and to Mr. Allen for the description of the very complete works which he has designed and built for the city of Worcester.

Prof. W. T. Sedgwick, of the Massachusetts Institute of Technology, Boston, spoke substantially as follows: —

Mr. Chairman and Gentlemen: — It seems to me to be a matter for congratulation that the City of Worcester has had the courage to introduce a method of sewage disposal entirely new to this vicinity, thus enabling us to observe the actual working of sewage disposal by chemical precipitation. It seems to me, furthermore, that Worcester has shown commendable enterprise in sending her engineer, Mr. Allen, to Europe and elsewhere, and in giving him afterwards the means to mature and carry out his plans. I desire to express my own personal pleasure in having been allowed to-day to witness the outcome of Mr. Allen's work. Hitherto, sewage problems have not given us very great solicitude, but as our country grows older and the density of population increases, we are bound to be confronted with new and more difficult problems of water supply and sewage disposal. And here I desire to express my thanks to Professor Kinnicutt for his full and interesting treatment of the subject before us to-day, — a subject which concerns vitally every officer of the public health and every intelligent citizen of the Commonwealth.

Among the numerous important questions arising out of this subject to which one might well address himself, I feel impelled to take up, for a moment, that in which I am personally most interested, namely, the question of the effect of the several methods of disposal upon the living organisms or "germs" in sewage. It must be distinctly understood that sewage is a decomposing fluid, and is crowded

with the germs of putrefaction. These are wholly invisible to the naked eye, although so abundant that the sewage of Lawrence, for example, contains usually more than half a million to the cubic centimeter (about a cubic — one-third of an inch). European sewage, being usually more concentrated, contains sometimes as many as five to fifteen millions of organisms to the cubic centimeter. I do not know of any bacterial analyses of Worcester sewage, and it may be that the acid which appears to be so abundant at times, may tend to diminish the number. Most of these "germs" are undoubtedly merely putrefactive and not pathogenic; but among them there may be some — like those of typhoid fever — which are dangerous disease germs. It becomes, then, an interesting question to inquire, What, precisely, is the influence of chemical precipitation upon the organisms of sewage?

For, while this question may seem comparatively unimportant if the effluent is not to be used for drinking and the end sought for is clarification rather than purification, it is quite otherwise in those cases in which the effluent is to be turned into a stream that may possibly be used at some point for drinking purposes. But even if clarification be all that is desired and purification is deemed unnecessary, there is still required a knowledge of the sewage organisms that survive in the effluent, since, if these be added to an ordinary stream, it is possible that in the presence of the residues of sewage precipitation, they may produce new and unlooked-for consequences in the main stream further on. Now it seems to me that it is this biological aspect of the question that most concerns an association like this, especially if we inquire, in the next place, What is the effect of any particular method of sewage disposal upon the disease-producing germs which must frequently occur in sewage?

At the Lawrence Experiment Station of the State Board of Health studies have been made of the two principal methods of sewage disposal, in respect to their influence upon the organisms of sewage.

The first method is that known as intermittent filtration, or the disposal of sewage upon sandy land. The second is chemical precipitation. In both methods the sewage organisms are materially reduced in numbers, but in chemical precipitation far less completely than in intermittent filtration. Very considerable concentration of the chemicals used is required if the results are to compare at all, bacteriologically, with the results obtained by simply pouring the sewage

upon finely sandy land. Now, if the object of a particular system of sewage disposal be clarification to prevent a nuisance, chemical precipitation will often suffice; but if purification, in the biological sense, be desired, it is infinitely less satisfactory. From the point of view of the public health, there can be little question that ordinary chemical precipitation leaves much to be desired. In the absence of careful experiments in this direction with specific disease germs, the question must, however, remain an open one. It would be especially interesting to experiment here at Worcester, since, according to Professor Kinnicutt, the sewage of Worcester is made acid by receiving waste from the manufacturing establishments, and it might appear upon investigation that this directly favors or hinders the life of the sewage organisms.

It may interest the association to know that it is possible by means of only five feet in depth of finely sandy soil to purify sewage so that all organisms are removed from it. I have frequently drunk of the effluent of such a sewage filter without observing any ill effects whatsoever, and others have done the same. This probably explains why so many wells that, from their surroundings, ought to be dangerous, really produce for a time no bad effect.

But, after all, a great volume of sewage, as we find it in cities like Worcester, seldom has to be purified to this extent. It will generally suffice if it be freed from offensiveness, and here chemical precipitation is probably, at present, most useful. Some experiments at the Lawrence Experiment Station, however, indicate that the proper use of small pebbles or coarse gravel stones as rapid filters, may hereafter prove to be cheaper and equally effective.

Charles A. Allen, City Engineer of Worcester.

Mr. President and Gentlemen: — I have not a great deal to say. You have visited our works and seen the result. It might be interesting for you to know what the practical result has been upon the river. Of course when I say the practical result I mean what the effect has been as the ordinary observer notices it. We have made no analyses of what the result below Worcester has been so far, but it is a common thing for people to come into my office who live, say, down at Saundersville or Whitinsville, and say something like this: "Have you been down the river lately?" "No," I reply, "I

have not." "Well, are you aware that the river is in a much better condition today than it has ever been before?" I generally expressed surprise; and I really am surprised. But we are told by people below that the river is very much cleaner than it has been for ten years.

I would like to explain further as to the amount of sewage we are treating, and also what we propose to do. We have the combined system of sewers, which care for surface water as well as for sewage proper. Nearly all of our sewers are planned in this way; a few of them, in outlying districts, are designed to care for domestic sewage only. We treat from three to four million gallons per day of polluted brook water; and, until we can take all the sewage to be treated, we don't expect and don't claim that the river will receive the full benefit of the process. I am now at work on the plans for the separating of brook water from the sewage, and in a year, or two years, we will convey all the sewage to the works and treat it.

The question has been asked today, several times, about the disposing of the solids, and whether our process is to be a permanent method, and I have answered the questions a number of times. I'll take the risk of explaining again. The land on which we dispose of the sludge is owned by the city and is some twenty acres in extent. We have the river on the east and the Providence and Worcester Railroad on the west. There is no possible way of getting on to that land except through our grounds and the right of way across the railroad, owned by us, so that it is entirely isolated. The ultimate disposal of the sludge will be by burning it; we first decided to see what could be done by storing it. We also wanted to see whether there was any chance of the sludge becoming a nuisance, so we have let it lie there all summer without covering it up. We have never had the least trouble from it, so that, as far as that question is concerned, it is safe to say that the sludge can be run into basins and dried, without any danger of becoming a nuisance, and it can be afterwards burned. My own opinion is that, in the course of a few years, we shall burn the sludge. The present method is not a permanent one, and ought not to be so considered. It was simply a matter of convenience. The works were not entirely completed when operations were begun; there were many things that we had to hasten to construct, and the disposal of the sludge was one of them.

Now we have found out that, after all, we know very little about

Worcester sewage; that is, about how it is made up. In the first place it is very much more acid than we expected. When we began to treat the sewage we had a good deal of difficulty in obtaining an effluent that would not be more or less discolored. When we took it and put it into a glass it looked very much like amber. But we very soon found, thanks to some experiments by the State Board of Health, that the trouble was that we did not neutralize all the acid. We experimented every five minutes during the day, neutralizing the acids with lime, and there was no further difficulty in getting a good effluent. The tendency at first was to use more lime than was necessary. I think the amount now used is one-half that used at first, and the result is equally as good.

We find that it is not always necessary to treat the sewage with chemicals as it flows into the tanks. That is where we take advantage of the acid in the sewage. Perhaps I can best illustrate what I mean by explaining our method of operating the tanks. Number one is emptied in season to receive the extremely acid sewage, the flow generally lasting about an hour and a half. This sewage is thoroughly treated with lime, and the tank is filled with it; the machinery is then stopped and crude sewage is run through the tank, and is thoroughly treated by the excess of chemical matter in the sewage just preceding it. We can frequently run four or five hours in this way with good results. It is very largely a question of manipulation, where a uniform effluent is desired.

Something has been said in relation to mechanical filters in place of intermittent filtration. If your cities and towns have the same experience that we have had, when they come to the point of disposing of their sewage, you will undoubtedly have an immense number of advisers in favor of mechanical filtration. I think, however, it may be said that sewage is very little improved by mechanical filtration.

[Mr. Allen at this point passed round several samples of the sewage that had been operated upon at the Worcester sewage works.]

Professor FULLER — Is it not quite possible that that is owing to the growth of bacteria?

Mr. ALLEN — I think it is quite likely, Professor Fuller. I am not an expert upon that point. There is one statement I wish to correct that Professor Kinnicutt made, inadvertently, perhaps, and that is about the difference in the quantity of water running into the river and in the sewer. He said, as I understood, that there was five

times the water running in the river as in the sewer. I think he must have meant the flow of Mill Brook. Judging by the water-sheds there would be about seven times the flow of water.

The tanks are similar in design to those at Leeds, England, and are of sufficient capacity to treat a greater amount of sewage then we now have.

When we first began to treat the sewage it was in this way: Tank number one was filled and then cut out, tank two filled and cut out, and so on through the series. In that way each tank would have from six to seven hours in which to rest, and the effluent obtained was very fine, indeed. It is a very much more expensive way of doing than the present method. It takes more men, and the difference in the effluent is not such as to seem to warrant the additional expense.

I entirely agree with Professor Drown that there is no one system of sewage treatment that is to be adopted in all cases. I think, however, it has resolved itself down into two systems, because I don't imagine that irrigation will be very extensively used. When I was in England I saw Mr. James Mansergh, who was the engineer of a very large number of important works, and who is now consulting engineer for the Metropolitan Board of Health in London, and he told me that in ten years, irrigation, as a means of disposing of sewage, would be entirely done away with. So that really we have but two ways — chemical precipitation, which is the method in use in Worcester, and downward intermittent filtration.

Now, just one more point I wish to touch upon, and that is, the liability of sewage-disposal works becoming a nuisance. Undoubtedly, some of you today were looking for more or less odor at our works. It is very natural that you should. I have visited many works abroad where the odor was anything but pleasant. It is simply a matter of manipulation and care, and keeping the works in the best possible condition. It does not matter whether the works are chemical precipitation or intermittent filtration, if they are properly looked after there need be no nuisance and no trouble. Therefore I say, keep your disposal-works out of politics. [Laughter and applause.]

Mr. French (of Newton) — I wish Mr. Allen would give us a few items in regard to the cost of maintenance

Mr. Allen — I have said nothing about the cost for the reason that we are continually changing and reducing the amount of chemi-

cal matter that we use. At the time the works were decided upon we calculated to deal with three million gallons a day at a cost of $22,500 a year, and we have been able to keep the cost considerably inside of that. We have only been running three months, and that is the reason why we have not given you the cost and a chemical analysis — simply because we are just beginning operations here.

Mr. FRENCH — Does that include the cost of the plant?

Mr. ALLEN — No, sir, it does not; simply the operating expenses. In London the price is something like a shilling a head. It will probably be more here, for labor is higher and chemicals are dearer.

Mr. FRENCH — What has been the actual cost of the plant?

Mr. ALLEN — The outfall sewer cost $75,000 and the tanks and machinery about $47,000. With some additional expenses for grading and the like, the total cost will be a round sum of something like $150,000 or $175,000.

Dr. BAKER — I think the gentlemen of the Association are greatly indebted to the city of Worcester for the interesting and instructive afternoon we have had here, and far more to the gentlemen who have given us such able and instructive addresses, and I, therefore, wish to move a vote of thanks to Professors Kinnicutt, Drown and Sedgwick, and Mr. Allen. I hope that some of this will reach print. I think the Society should have in permanent form the result of this report. [Applause.]

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JAN. 1, 1891.

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